[Document Name] Description

[Title of the Invention] The junction method of a metallic powder brazing material and an alumimium nitride member, and metal department material

[Claim(s)]

[Claim 1] (1) A silver-copper eutectic alloy powder 100 weight part, (2) silver, copper, Or the metallic powder brazing material which (1) is a silver-copper alloy from which a composition ratio differs, and the melting point consists of a metal higher 60 degrees C or more than the melting point of (1), and contains 10 - 60 weight part and (3) active-metal powder 0.1 - 5 weight parts in the end of alloyed powder whose average particle diameter is 1-85 micrometers.

[Claim 2] The junction method of of the alumimium nitride member and metal department material which are characterized by pasting these together and subsequently heating in the method of joining an alumimium nitride member and metal department material after applying a brazing material according to claim 1 to at least one bonded surface of an alumimium nitride member or metal department material.

[Detailed Description of the Invention]

[0001]

[Field of the Invention] This invention relates to the method of joining an alumimium nitride member and metal department material through the suitable metallic powder brazing material for junction to an alumimium nitride member and metal department material, and this brazing material.

[0002]

[Description of the Prior Art] The zygote of metal department material and a ceramic member is variously studied and used as an electronic circuit or a structure material. Also in ceramics, since it excels in heat dissipation nature and insulation, an alumimium nitride board joins metal to this, and is being widely used as IGBT (high electric power electronic circuit board) in recent years. Moreover, as a metal used for this, from points, such as an electrical property, it is made most advantageous to use copper and it inquires present most briskly.

[0003] As a conjugation method of a copper plate and an alumimium nitride board The active metal solder which joins using the brazing material which added the active metal which has reactivity with alumimium nitride (For example, JP,S60-32343,A) What is called a DBC method (for example, JP,S59-40404,A) that heats the alumimium nitride board and copper plate which carried out surface oxidation treatment more than the eutectic crystal temperature of below the copper melting point and Cu2 O-O, and is joined is known. As compared with the DBC method, the surface oxidation treatment of active metal solder of (1) alumimium-nitride board is unnecessary. (2) Welding temperature is low and the remaining stress by the coefficient-of-thermal-expansion difference of copper and an alumimium nitride sintered compact is reduced. (3) There is little poor junction and junction intensity is stable. (4) Even if it heat-treats in a hydrogen air current, there is little degradation of a junction layer. There is which advantage.

[0004] The method of obtaining the alumimium nitride board by which the desired electric conduction pattern was joined on the substrate is proposed by joining a copper plate, after printing a brazing-material paste by a desired pattern on an alumimium nitride board, in order to employ this characteristic efficiently, and etching only the unnecessary portion of a copper plate.

[0005]

[Problem to be solved by the invention] [when soldering generally, what has the good wettability of a brazing material and junction material is called for, but] You have to make it a brazing material not have to flow into a non-connecting part in soldering of the substrate that the non-connecting part by which metal is not joined to the junction to which metal was joined like a circuit board lives together, more than needed. However, if a substrate is heated more than the melting point of a brazing material when joining, after forming the pattern of a brazing material The liquid phase generated and flowed in the brazing material, the brazing material flowed into the portion which must guarantee insulation, a part for i.e., a non-connecting part, and which poor problem by the outflow of the brazing material to the short circuit and insulating pattern part between patterns had occurred.

[0006] Also when applying to the pattern of the request of a brazing material to an alumimium nitride board and joining copper section material, in order that it may have been an important technical problem to prevent the outflow of a brazing material and it may solve the above-mentioned problem The method of adding a high-melting metal from a

brazing-material ingredient in a brazing material is proposed (JP,H2-6096,A). However, by this method, by having added the high melting point metal, a brazing-material layer hardens and the problem that the heat-resistant shock nature of a zygote falls occurs. However, by this method, by having added the high melting point metal, a brazing-material layer hardens and the problem that the heat-resistant shock nature of a zygote falls occurs. As the technique of controlling other brazing-material outflow, the technique of controlling the particle diameter of the powder and controlling outflow is proposed in the charge of a paste-like jointing material of a Ti(or Nb, Zr)-Cu-Ag system (JP,H5-246770,A). However, the thing which according to the place which this invention persons checked liquid phase generation speed is slow and the problem of being easy to generate a void is in the inside of the interface of metal department material and a brazing material, or a brazing material by the above-mentioned method, In order to acquire a good junction state by a copper plate-brazing-material interface, forming [brazing material / a brazing material needs to fuse promptly and]-at time of heating,-the liquid phase ** became clear.

[0007] Moreover, in the brazing material having contained the active metal, the method of adding the ceramic powder which has reactivity with an active metal as a method of controlling the outflow in a brazing material is proposed (JP,H4-108673,A). However, since some ceramic powder decomposed in this method at the time of heating junction and the gas of a nonmetallic ingredient occurred, the problem had arisen that it is easy to generate a void inside a brazing material.

[0008]

[A means to solve invention] In order that this invention persons may solve the above problem, when it inquires wholeheartedly, silver-copper eutectic alloy powder, silver, copper, Or it finds out that what is necessary is just to use the metallic powder brazing material constituted with the metallic powder which consists of a silver-copper alloy from which this silver-copper eutectic alloy and a composition ratio differ, and active metal powder, and this invention is completed.

[0009] This invention Namely, a (1) silver-copper eutectic alloy powder 100 weight part, (2) silver, copper, Or (1) is a silver-copper alloy from which a composition ratio differs, and the melting point consists of a metal higher 60 degrees C or more than the melting point of (1). It is the way average particle diameter joins an alumimium nitride member and metal department material through the metallic powder brazing material and this brazing material which contain 10 - 60 weight part and (3) active-metal powder 0.1 - 5 weight parts in the end of alloyed powder which is 1-85 micrometers.

[0010]

[Mode for carrying out the invention] In this invention, with a silver-copper eutectic alloy, it is the crystal mixture which deposits simultaneously from the melting object

containing silver and copper, and the composition which forms a eutectic crystal is called eutectic crystal composition. The silver-copper eutectic alloy powder which is an ingredient (1) is the powder of the crystal mixture of the eutectic crystal composition whose composition is 72 weight % of silver, and 28 weight % of copper, and the melting point is 780 degrees C and is the lowest in the alloy of silver and copper.

[0011] Although the average particle diameter in particular of silver-copper eutectic alloy powder is not restricted, when screen-stenciling, its 85 micrometers or less are desirable, and 1-50 micrometers is more suitable for it. The particle diameter of silver-copper eutectic alloy powder can be measured using a centrifugation method. In addition, by a centrifugation method, when a variant [a powdered form], distinction of the major axis and a minor axis will not stick, but it will consider that average value is particle diameter, but on these Descriptions, it supposes that it is considered that this average value is particle diameter, and distinction of the major axis about particle diameter and a minor axis is not carried out. Moreover, the particle diameter in this Description points out not condensation particle diameter but primary particle diameter.

[0012] Although the atomizing method, the grinding method, etc. exist variously as a process of silver-copper eutectic alloy powder, in this invention, it is not restricted to these processes at all. Moreover, [eutectic alloy powder] although composition may be changed according to the conditions at the time of manufacture etc. and the melting point may go up It is possible to permit change of forbearance composition enough in this invention, and specifically, what the melting point rise produced by change of composition will cause no inconvenience in any way, if the margin of increase is less than 5 degrees C.

[0013] Silver, copper, or (1) are a silver-copper alloy from which a composition ratio differs, and the metallic powder of the ingredient (2) in this invention consists of metal the melting point is higher than the melting point of (1) 60 degrees C or more, and is in the end of alloyed powder whose average particle diameter is 1-85 micrometers. When the metallic powder of an ingredient (2) is the silver-copper alloy in which a composition ratio differs from (1), unless it is higher than the melting point of the silver-copper eutectic alloy of (1) 60 degrees C or more, at the time of melting of a silver-copper eutectic alloy, the metallic powder of (2) fuses simultaneously substantially and cannot control outflow of a brazing material.

[0014] Although any metal other than the ingredient from which the metallic powder of an ingredient (2) constitutes silver-copper eutectic alloy powder is not included substantially, impurities, such as unescapable Fe mixing is expected to be in carrying in or manufacture from materials, Cr, nickel, Si, Mg, O, C, and N, may be contained.

[0015] Moreover, as for the metallic powder of an ingredient (2), 1-85 micrometers of 5-45-micrometer things are preferably adopted for average particle diameter. If average particle diameter is larger than 85 micrometers, application of screen-stencil will

become difficult as the application method, and if smaller than 1 micrometer, the effect which controls that the brazing material fused at the time of junction flows into an insulating pattern part will become small.

[0016] In this invention, the mixture ratio of an ingredient (1) and an ingredient (2) is ingredient (2) 10 - 60 weight part to an ingredient (1) 100 weight part. If the fault which a void generates inside a junction interface or a metallic powder brazing material happens easily and it becomes under 10 weight parts when the ingredient (2) was contained as for more than 60 weight parts and it joins, the control effect of fault that the melting ingredient of this metallic powder brazing material flows into an insulating pattern part is inadequate.

[0017] In order to secure a wettability with the member which consists of an alumimium nitride sintered compact at the time of melting, the active metal powder which has reactivity with an alumimium nitride member is blended with the metallic powder brazing material of this invention. as an active metal -- the [periodic law table] -- the element belonging to IVa fellows and its hydrogenation thing can be used, and, generally titanium, JIRUKONIUMU, and hafnium are used. Also in this, especially titanium has high reactivity with an alumimium nitride member, and since junction intensity can be made very high, are desirable. Furthermore, since oxidizing before a junction process and losing activity will be lost and it will become activity titanium metal by heat-treatment of a junction process if hydrogenation titanium is used, a suitable junction state is acquired. Although the average particle diameter in particular of active metal powder is not restricted, when screen-stenciling, its 85 micrometers or less are desirable, and 1-50 micrometers is more suitable for it.

[0018] In order to maintain junction intensity sufficient between a metallic powder brazing material and Ceramics Sub-Division and to suppress the fall of heat-resistant shock nature, the amounts of addition of active metal powder are 0.1 weight part - 5 weight parts to a silver-copper eutectic alloy powder 100 weight part. If there are few amounts of addition than 0.1 weight part, **** of a metallic powder brazing material and an alumimium nitride member will not be enough, and sufficient junction will not be obtained. Moreover, if more than 5 weight parts, the problem that the heat-resistant shock nature of the joined alumimium nitride member falls will occur.

[0019] As for a metallic powder brazing material, applying uniformly on a member is desirable, as the application method, it sprays and the screen-stenciling method, the roll coat method, and arbitrary methods, such as transfer, are adopted. Although the screen-stenciling method is generally the simplest, since the **** ball of a screen etc. is generated and it may be unable to print to a desired pattern if a big and rough grain is in a metallic powder brazing material, it is desirable that a big and rough grain is not included. Since the screen of a fine mesh must be used and it is easier to generate a **** ball, in printing a more detailed pattern Controlling to 100 micrometers or less is suitable for the maximum particle diameter of the ingredient (1) of a metallic powder brazing material, (2), and (3), and it is 85 micrometers or less still more preferably.

[0020] The mixed method of each ingredient which constitutes a metallic powder brazing material is adopted that a well-known method does not especially have restriction. Generally well-known mixers, such as a ball mill, attritor, a planetary mixer, and 3 RORUMIRU, are used.

[0021] Moreover, as for a metallic powder brazing material, it is desirable to blend the organic solvent and a binder, and to use it, kneading in the shape of a paste so that it may be easy to form a pattern by methods, such as screen-stencil. When making it the shape of a paste, if it is considered as the organic solvent, one sort or two sorts or more of mixtures, all [TEREPINE / MECHIRUSERUSORUBU, ethyl cell SORUBU, iso holon, toluene, ethyl acetate, and], TEKISANORU, etc., are used. As a binder, ethyl cellulose, methyl cellulose, nitroglycerine cellulose, organic polymer objects, such as hydrocarbon system synthetic resin; polyvinyl chloride; wax, its emulsion, etc., such as oxygenated organicity polymer object; oil resin, such as poly acrylate and poly methyl methacrylate, polyethylene, polypropylene, and polystyrene, -- one sort -- or two or more sorts are mixed and it is used.

[0022] In order to screen-stencil the good pattern of a metallic powder brazing-material paste, it is desirable to control the viscosity of this brazing-material paste to 20 - 300kcps. The metallic powder brazing-material paste which was excellent in printing nature can be obtained by blending a binder in 1 to 5weight % of the range five to 15weight % as a rate of occupying the organic solvent to this whole brazing-material paste. In addition, by blending a binder in the above-mentioned range, removal of the binder in the degreasing process after printing is performed promptly, and is suitable.

[0023] Moreover, when making a metallic powder brazing material into the shape of a paste, a dispersing agent can also be added in order to improve the dispersibility of each ingredient. As a dispersing agent, the glycerin of fatty acid, such as a glycerin trio rate and a sorbitan trio rate, or sorbitol ester, wild fish oil, the synthetic surface-active agent of a non-ion system, higher fatty acid, benzenesulfonic acid, etc. are used, for example. Although it changes with the kind of dispersing agent, kinds of mixed system to add, etc. and cannot generally be limited, if the amount of these dispersing agents used is preferably chosen from 0.05 to 1weight % of the range, it is suitable 0.01 to 5weight % at a rate of generally occupying during [whole] a paste.

[0024] By using the metallic powder brazing material of this invention, there is no outflow of the melting brazing material at the time of junction to an alumimium nitride member and metal department material, it becomes possible to perform good junction of a junction state, and the yield improves.

[0025] As metal department material with which junction to an alumimium nitride member is presented through a metallic powder brazing material, if it has a high-melting point from welding temperature, there will be no restriction in particular. It is possible to use copper, a copper alloy, silver, a silver alloy, nickel, a nickel alloy, molybdenum,

tungsten, an iron alloy, etc. It is most desirable from points, like there are little electric resistance and ductility, and migration to use copper as metal department material also in this. In addition, if it uses molybdenum and tungsten in it will also be desirable to use silver and attaching greater importance than to an electrical property to the reliability after junction, if electric resistance is thought as important Since the coefficient of thermal expansion of this metal is close to the coefficient of thermal expansion of alumimium nitride and the heat stress at the time of junction can be made small, it is desirable.

[0026] The member joined by the metallic powder brazing material of this invention does not necessarily need to be bulk-like, and can be used also for filmy alumimium nitride and the metal which were formed in the surface of bulk, such as Ceramics Sub-Division, metal, and glass. Moreover, the metallic powder brazing material of this invention can also be used for the use which forms a metal layer by applying on independent members, such as not only the use as the brazing material or solder for joining two or more members but alumimium nitride, and metal, and heating.

[0027] The general junction method which used the metallic powder brazing material of this invention for below is shown.

[0028] First, a metallic powder brazing-material paste is applied to up to a member so that it may become a desired pattern by screen-stencil. As an application form of a metallic powder brazing material, restriction does not have the application to both the application of a up to [an alumimium nitride member], the application to metal department material, an alumimium nitride member, and metal department material etc. in any way.

[0029] After applying a metallic powder brazing material, it is desirable to degrease generally and to remove a binder ingredient. Although it changes variously with binder ingredients about processing conditions, such as cooking temperature under degreasing, and time, if it processes in atmosphere like [atmosphere / in nitrogen and argon] where it does not oxidize, or a vacuum, it is suitable, without an active metal oxidizing. Moreover, if an active metal does not oxidize with restricting the amount of oxygen more than needed even if it is oxidization atmosphere, even if it degreases in atmosphere and wet atmosphere where very-small-quantity oxygen exists, a suitable junction state can be acquired. Wet atmosphere is the atmosphere formed by ****(ing) atmosphere [where it does not oxidize] gas to a processing room after letting the inside of water or hot water pass here.

[0030] Subsequently, the metallic powder brazing material which degreasing finished piles up members so that it may be arranged between an alumimium nitride member and metal department material, and it joins at the temperature which this metallic powder brazing material fuses. In order for a metallic powder brazing material to fully wet an alumimium nitride member and the metal department material surface and to prevent the fall of the heat-resistant shock nature by remaining stress from the difference in the

coefficient of thermal expansion of an alumimium nitride member and metal department material, 800-950 degrees C of welding temperature are desirable. In order that junction may prevent oxidization of active metal powder and metal department material and may acquire a good junction state, it is desirable to carry out in the vacuum of 1x10 to 4 or less Torr or under non-oxidizing atmosphere, such as nitrogen with an oxygen concentration of 10 ppm or less, hydrogen, and argon. Furthermore, by applying 1-50g/cm2 of load at the time of junction, a metallic powder brazing material, an alumimium nitride member, and metal department material can be contacted more certainly, and a good junction state can be acquired.

[0031] Thus, the junction pattern as the pattern applied at the application process of the metallic powder brazing material with obtained same zygote is formed. The alumimium nitride junction material which there is no outflow of the metallic powder brazing-material ingredient fused by performing resist application and etching processing succeedingly, and has the good metal circuit pattern of a junction state can be manufactured.

[0032] Moreover, when a metal circuit pattern oxidizes easily, in order to prevent oxidization of this metal, you may form plating coats, such as non-electrolyzed nickel, in the surface of metal after etching processing.

[0033] The discovery mechanism of the effect at the time of using the metallic powder brazing material of this invention is guessed as follows. Namely, [when the mixture of an ingredient (1) and an ingredient (2) is heated to the melting temperature of an ingredient (1), get wet and spread in the member which fuses an ingredient (1) promptly and with which junction is presented, but] Since the melting point is higher than an ingredient (1) 60 degrees C or more, an ingredient (2) functions as a spacer holding the thickness of the metallic powder brazing-material layer which exists as a solid phase state and contains the fused ingredient (1), without fusing. For this reason, it is thought that the outflow to the insulating pattern part of a good melting metal by junction pressure at the same time it gets wet and the state of a spread is acquired is controlled in the melting early stage of a metallic powder brazing material between this metallic powder brazing material and the member with which junction is presented.

[0034] Furthermore, in the stage heated more than the melting temperature of an ingredient (1), in order that the ingredient (2) may dissolve into the liquid phase, composition of the melting metal of a metallic powder brazing material shifts, and the melting point goes up. For this reason, the effect which controls the viscosity fall of the melting metal by a rise in heat in the stage on and after the melting first stage of a metallic powder brazing material is added, and it is thought that the outflow to an insulating pattern part is controlled.

[0035]

[Effect of the Invention] By joining an alumimium nitride member and metal department material using the metallic powder brazing material of this invention, the alumimium nitride junction material which there is no outflow of a brazing material and has the good metal circuit pattern of a junction state can be manufactured with the sufficient yield.

[0036]

[Working example] Although a work example and a comparative example are given and this invention is explained in detail hereafter, this invention is not limited to these work examples.

[0037] In the end (1083 degrees C of melting points) of copper powder to the eutectic alloy powder 100 weight part of work-example 1 silver and copper 50 weight parts, At a rate of occupying to the whole paste in the end of the mixed powder which added the hydrogenation titanium powder 1.5 weight part 8 weight % of TEREPINE oars, After blending 3 weight % of poly methyl methacrylate, and 0.1 weight % of dispersing agents, it mixed using the planetary mixer, and the metallic powder brazing-material paste of 120kcps was manufactured. The average particle diameter in the eutectic alloy powder of silver and copper and the end of copper powder is 8.0 micrometers and 11.6 micrometers, respectively, and hydrogenation titanium powder used that whose average particle diameter is 3.6 micrometers.

[0038] This metallic powder brazing-material paste was applied to the predetermined pattern by screen-stencil on the alumimium nitride board (54mm x 36mm).

[0039] Then, it dried and degreasing was performed for 5 minutes in 320-degree C nitrogen-gas-atmosphere mind. Furthermore, after piling up with copper section material-nitriding ARUMUNIUMU member-copper section material, applying 10g/cm2 of load, among the vacuum (10-5Torr), heat treatment of maintenance was given at 850 degrees C for 15 minutes, and junction of copper section material and an alumimium nitride member was performed. Then, printing of a brazing-material pattern and the same resist pattern and the copper section material of the unnecessary portion were removed, and desired copper-alumimium nitride junction material was produced.

[0040] The frequency of the brazing-material outflow to the non-connecting part by macro-scopic observation was zero sheet among 40 sheets. When the junction state was observed with the ultrasonic **** machine, the frequency of void generating where the area of the junction poor part by void generating was 5% or more to the area of the whole junction part was zero sheet among 40 sheets.

[0041] The material shown in two to work-example 5 table 1 was used, and also the metallic powder brazing-material paste was produced like the work example 1, and

copper-alumimium nitride junction material was produced by the same method as a work example 1. That whose average particle diameter is 8.3 micrometers as the end of silver dust (960 degrees C of melting points), and titanium powder used that whose average particle diameter is 4.2 micrometers here.

[0042] Thus, the obtained junction material did not have the outflow of the brazing material to a non-printed part, and observation by ultrasonic exploration equipment of the junction state was also good. Brazing-material outflow frequency and void generating frequency are shown in Table 1.

[0043] The material shown in Table 1 as one to comparative example 7 comparative example was used, and also the metallic powder brazing-material paste was produced like the work example 1, and copper-alumimium nitride junction material was produced by the same method as a work example 1. That whose average particle diameter is 8.1 micrometers as the end of Ag/Cu alloyed powder whose bulk density is 85/15 here, and the thing whose average particle diameter is 8.3 micrometers as the end of silver dust were used.

[0044] Thus, the fault by void generating of a junction was looked at by observation according [the obtained junction material] to the outflow or ultrasonic exploration equipment of a brazing material. The result was shown in Table 1.

[0045]

[Table 1]

[Translation done.]